Appendix Table 1. Primary Outcomes of Interest

Quality of care outcomes	Outcome measures
Screening and other preventive care services completed or ordered	Screening for hypertension, hyperlipidemia, and diabetes in people not diagnosed with a CVD risk factor. Other preventive care services included providing aspirin (when appropriate), providing smoking cessation counseling, and nutrition and physical activity assessments included in USPSTF recommendations.[18-22]
Clinical tests completed or ordered	Clinical tests from evidence-based guidelines and protocols for management of hypertension, hyperlipidemia, or diabetes. Examples: hemoglobin A1C testing every 6 months for patients with diabetes[6]; blood pressure and cholesterol testing for patients diagnosed with hypertension and hyperlipidemia, respectively.[7,8]
Treatments prescribed	Recommendations to initiate, intensify, or change existing medications for patients with hypertension, hyperlipidemia, or diabetes, based on clinical guidelines.
CVD risk factor outcomes	
Blood pressure outcomes	Proportion of patients with their BP controlled (usually defined as ≤140/90 mmHg and ≤130/80 mmHg for people with diabetes)[8] Change in mean SBP Change in mean DBP
Lipid outcomes	Proportion of patients achieving established targets (or better) for TC, LDL-cholesterol, HDL-cholesterol, and triglycerides[23] Changes in mean TC, LDL-cholesterol, HDL-cholesterol, and triglycerides
Diabetes outcomes	Proportion of patients achieving A1C control (usually defined as ≤7%)[6] Changes in mean A1C level Changes in mean blood glucose levels
Other primary outcomes	
Morbidity, mortality, and patient-centered outcomes	Incidence of heart attacks and strokes CVD-related hospitalizations and ED visits Patient satisfaction with care Health-related quality of life

BP, blood pressure; DBP, diastolic blood pressure; ED, emergency department; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SBP, systolic blood pressure; TC, total cholesterol.

Appendix Table 2. Calculation of Individual Study Effect Estimates for Primary and Secondary Outcomes

Effect estimate	Formula
Absolute percentage point change [a,b]	$(\text{CDSS Prop}_{post} - \text{CDSS Prop}_{pre}) - (\text{UC Prop}_{post} - \text{UC Prop}_{pre})$
Difference-in-differences of the mean [a,b]	$(\text{CDSS M}_{post} - \text{CDSS M}_{pre}) - (\text{UC M}_{post} - \text{UC M}_{pre})$

[a]For studies reporting multiple intervention arms, effect estimates were calculated for each arm and reported separately.
[b]When studies reported multiple outcome measures (e.g., studies reporting multiple types of clinical tests), effect estimates for each measure were calculated and reported separately.

CDSS, clinical decision-support system; Prop, proportion of patients achieving desired outcome; Post, measurement from last available time point with ongoing CDSS; Pre, last measurement before intervention; UC, usual care; M, mean, average for patient group.

Appendix Table 3. Changes in Blood Pressure, Lipid, and Diabetes Outcomes Attributable to Clinical Decision-Support Systems

Outcome type	Number of studies	Median effect estimate (IQI)
Blood pressure outcomes		
Improvement in proportion of patients with BP at goal[a]	8[25,33,39,41,52,63,65,82]	+2.0 pct pts (–5.0, 10.5)
Reduction in SBP	14[25,26,37-39,41,45,50,51,58,63,65,83,85]	–0.89 mmHg (–1.93, 1.0)
Reduction in DBP	11[26,38,39,41,45,50,51,65,71,83,85]	–0.30 mmHg (–1.13, 1.0)
Lipid outcomes		
Improvement in proportion of patients with lipid at goal[b]	9[26,33,41,45,65,81,82,85,92]	+1.0 pct pts (–1.25, 4.55)
Reduction in total cholesterol	5[26,27,37,38,84]	0 mg/dL (–7.35, 4.4)
Reduction in LDL cholesterol	10[26,27,29,41,45,58,65,83-85]	–0.5 mg/dL (–2.4, 0.2)
Improvement in HDL cholesterol	3[26,27,84]	–0.27 mg/dL (NA)
Reduction in triglycerides	2[27,84]	–21.4 mg/dL (NA)
Diabetes outcome		
Improvement in the proportion of patients with A1C at goal[c]	8[26,33,41,45,65,82,85,92]	–1.3 pct pts (–2.15, 4.23)
Reduction in A1C level	11[26,29,38,41,45,52,58,65,83-85]	–0.12% (–0.28, 0)

[a]Absolute percentage point increase in proportion of patients achieving goal BP.
[b]Absolute percentage point increase in proportion of patients achieving goal lipid levels.
[c]Absolute percentage point increase in proportion of patients achieving goal A1c levels.

BP, blood pressure; DBP, diastolic blood pressure; HDL, high-density lipoprotein; IQI, interquartile interval; LDL, low-density lipoprotein; NA, not applicable; pct pts, percentage points; SBP, systolic blood pressure.

Appendix Table 4. Changes in Quality of Care Outcomes from Studies Examining Clinical Decision-Support Systems Combined with Other Interventions

Additional intervention delivered	Quality of care outcome	Study author (year)	Quality of care findings [a]
Team-based care	Screening and other preventive care services completed or ordered	Holbrook (2011)[83]	• Change in total process composite score (95% CI): +4.7 (3.63 to 5.71)
	Clinical tests completed or ordered	Dorr (2005)[29]	• HbA1c testing completed: OR (95% CI): 1.5 (1.3 to 1.7) • LDL testing completed: OR (95% CI): 1.3 (1.0 to 1.6)
		O'Connor (2005)[52]	• Prop of patients with ≥2 HbA1c tests: +33.0 pct pts (p=0.002) • Prop of patients with ≥1 LDL test: +16.0 pct pts (p=0.12) • Prop of patients with ≥2 HbA1c tests and with ≥1 LDL test: +25.0 pct pts (p=0.03)
	Treatments prescribed	Hicks (2008)[39]	• Prop of patients with recommended drug class prescribed: +2.0 pct pts (p<0.001)

		Murray (2004)[51]	• Prop of patients prescribed antihypertensive medications (95% CI)
			  • Arm 1: Pharmacist + CDSS vs. UC –2.0 pct pts (–1.90 to 7.90)
			  • Arm 2: Pharmacist + MD + CDSS vs. UC: +2.0 pct pts (–7.80 to 11.80)

Patient reminders	Screening and other preventive care services completed or ordered	Holbrook (2009)[41]	• Change in BP process composite score: +0.61 (p<0.001) • Change in BMI process composite score: +0.71 (p<0.001) • Change in exercise process composite score: +0.91 (p<0.001) • Change in diet process composite score: +0.88 (p<0.001) • Change in aspirin process composite score: +0.05 (p=0.02) • Change in smoking process composite score: +0.03 (p=0.09)

		Ornstein (1991)[53]	• Prop of patients receiving cholesterol screening
			  • Arm 1: CDSS vs UC: +9.10 pct pts (p<0.001)
			  • Arm 2: CDSS + patient reminder vs UC: +18.6 pct pts (p<0.001)

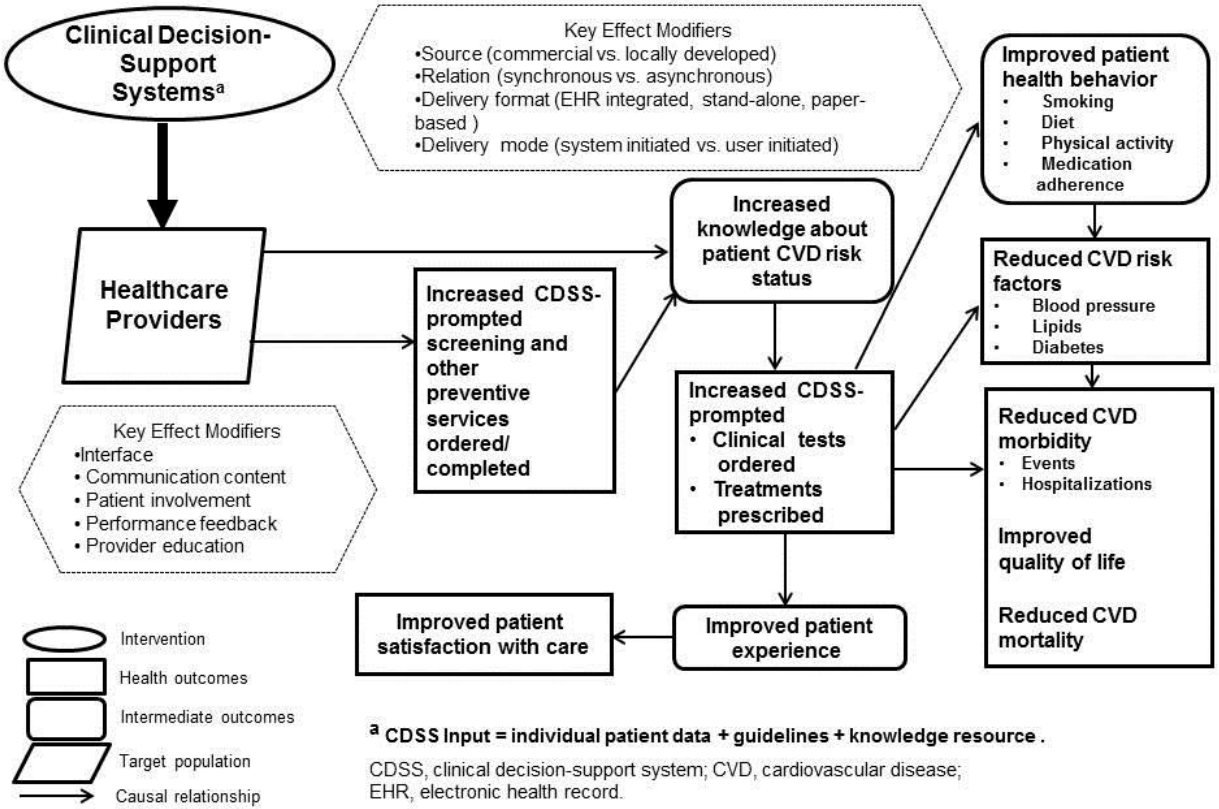
[a]Findings are individual effect estimates (absolute percentage point difference or difference-in-differences of the mean or odds ratios) on the effectiveness of a CDSS intervention compared with usual care.
BP, blood pressure; CDSS, clinical decision-support system; pct pts, percentage points; Prop, proportion; UC, usual care

Appendix Table 5. CDSS Contextual Factors and Features for Health Process Outcomes

Contextual factor/feature	Number of studies reporting (% of included studies) N=45	Number of studies reporting favorable outcome measures for screening and other preventive services (% of total studies reporting outcome) *n*=17	Number of studies reporting favorable outcome measures for clinical tests ordered (% of total studies reporting outcome) *n*=7	Number of studies reporting favorable outcome measures for treatments prescribed (% of total studies) *n*=11
Integration with charting or order entry system to support workflow integration	33 (73.3)	9 (52.9)	3 (42.9)	5 (45.5)
Automatic provision of decision support as part of clinician workflow	38 (84.4)	10 (58.8)	4 (57.1)	6 (54.5)
No need for additional clinician data entry	24 (53.3)	6 (35.3)	2 (28.5)	5 (45.5)
Request documentation of the reason for not following CDSS	4 (8.9)	2 (11.8)	1 (14.3)	0 (0)
Provision of decision support at time and location of decision making	35 (77.8)	9 (52.9)	3 (42.9)	6 (54.5)
Recommendations executed by noting agreement	3 (6.7)	2 (11.8)	0 (0)	1 (9.1)
Provision of a recommendation not just an assessment	41 (91.1)	10 (58.8)	5 (71.4)	7 (63.6)
Promotion of action rather than inaction	15 (33.3)	4 (23.5)	1 (14.3)	3 (27.2)
Justification of decision support via provision of reasoning	8 (17.8)	1 (5.9)	0 (0)	1 (9.1)
Justification of decision support via provision of research evidence	11 (24.4)	1 (5.9)	1 (14.3)	1 (9.1)
Local user involvement in development process	18 (40)	2 (11.8)	2 (28.6)	1 (9.1)

Provision of decision support results to patients as well as providers	8 (17.8)	2 (11.8)	1 (14.3)	1 (9.1)
CDSS accompanied by periodic performance feedback	11 (22.9)	2 (11.8)	1 (14.3)	2 (18.1)
CDSS accompanied by conventional education	12 (25)	4 (23.5)	0 (0)	3 (27.2)

Appendix Figure 1. Analytic framework: clinical decision-support systems for cardiovascular disease prevention.



Appendix Figure 2. Search process.